Claims

[1] A photocatalyst material producing method characterized by comprising

forming a discharge zone with a discharge gap part defined therein by first and second electrodes facing each other and arranging a dielectric material on a surface of the first electrode facing to the second electrode

coating the second electrode or the surface of the dielectric material with a metal or metal compound to be a photocatalyst material,

supplying oxygen gas into the discharge gap part, applying an AC voltage between the first electrode and the second electrode to introduce AC power of a predetermined power density into the discharge zone, causing dielectric barrier discharge (silent discharge or creeping discharge) via the dielectric material, creating a state where oxygen gas and ozone gas exist in the discharge gap part, and

modifying the surface of the dielectric material or the surface of the second electrode contacting the discharge gap part to an oxidized surface by a mutual chemical reaction of high-field intermittent discharge plasma due to the dielectric barrier discharge (silent discharge or creeping discharge) and oxygen gas and ozone gas, thus adhering a photocatalyst material to the surface of the dielectric material or the metal surface.

[2] The photocatalyst material producing method as claimed in claim 1, characterized in that gas pressure in the discharge gap part or AC power injected into the discharge zone is varied in accordance with an element material to be a photocatalyst material coating the second electrode or the surface of the dielectric material, thereby controlling a predetermined power density.

[3] The photocatalyst material producing method as claimed in claim 1, characterized in that the metal or metal compound to be the photocatalyst contains one or more elements of CU, In, Zn, Fe, Cr, Pb, V, W, Bi, Nb and Sr.

[4] A photocatalyst material producing method characterized by comprising

forming a discharge zone with a discharge gap part defined therein by first and second electrodes facing each other and arranging a dielectric material on a surface of the first electrode facing to the second electrode,

supplying staring material gas containing metal particles or metal compound gas to be a photocatalyst element in oxygen gas to the discharge gap part, applying an AC voltage between the first electrode and the second electrode to introduce AC power of a predetermined power density into the discharge zone, causing dielectric barrier discharge (silent discharge or creeping discharge) via the dielectric material, creating a state where oxygen gas and ozone gas exist in the

discharge gap part, and

modifying the metal particles or the metal compound gas contained in the oxygen gas to photocatalyst particles by a mutual chemical reaction of high-field intermittent discharge plasma due to the dielectric barrier discharge (silent discharge or creeping discharge) and oxygen gas and ozone gas.

[5] The photocatalyst material producing method as claimed in claim 4, characterized in that gas pressure in the discharge gap part or AC power injected into the discharge zone is varied in accordance with metal particle or metal compound gas type to be a photocatalyst element contained in the starting material gas, thereby controlling a predetermined power density.

[6] The photocatalyst material producing method as claimed in claim 4, characterized in that the metal particle or metal compound gas contains one or more elements of CU, In, Zn, Fe, Cr, Pb, V, W, Bi, Nb and Sr.

[7] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that the purity of the oxygen gas is 99.99% or higher.

[8] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that a product value of a gap length dg of the discharge gap part and a gas pressure P is defined as (P+0.1)*dg value, and the (P+0.1)*dg value is 0.14 (MPa*mm) or less.

[9] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that the frequency of an AC power source that injecting AC power of the predetermined power density is set at a predetermined frequency or lower, or at 30 kHz or lower.

[10] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that dilute gas to be auxiliary starting material gas is contained in the oxygen gas to enhance photocatalyst material production efficiency.

[11] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that electrode cells, each including the first electrode, second electrode and dielectric material, are stacked in multiple stages or the area of the electrodes is increased to increase injected AC power, thus enabling simultaneous production of a large quantity of photocatalyst material particles, a large photocatalyst surface, and a plurality of photocatalyst plates.

[12] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that nitrogen gas is contained in the oxygen gas and a photocatalyst material containing nitrogen is produced.

[13] The photocatalyst material producing method as claimed in claim 1 or 4, characterized in that ozonized oxygen gas containing ozone is supplied by an ozonizer that provided on a previous stage.

[14] A photocatalyst material producing apparatus characterized by comprising:

a photocatalyst material producing unit housing a first electrode, a second electrode facing this first electrode to form a discharge zone with a discharge gap part defined therein, and a dielectric material arranged on a surface of the first electrode facing to the second electrode;

oxygen supply means that supplies oxygen gas into the discharge gap part in the photocatalyst material producing unit; and

an AC power source that applies an AC voltage between the first electrode and the second electrode to introduce AC power of a predetermined power density into the discharge zone and causes dielectric barrier discharge (silent discharge or creeping discharge) via the dielectric material;

wherein a metal or metal compound to be a photocatalyst material is applied to the second electrode or the surface of the dielectric material,

a state where oxygen gas and ozone gas exist in the discharge gap part is created by the dielectric barrier discharge, and

the surface of the dielectric material or the surface of the second electrode contacting the discharge gap part is modified to an oxidized surface by a mutual chemical reaction of high-field intermittent discharge plasma due to the

dielectric barrier discharge (silent discharge or creeping discharge) and oxygen gas and ozone gas, thus adhering a photocatalyst material to the surface of the dielectric material or the metal surface.

[15] A photocatalyst material producing apparatus characterized by comprising:

a photocatalyst material producing unit housing a first electrode, a second electrode facing this first electrode to form a discharge zone with a discharge gap part defined therein, and a dielectric material arranged on a surface of the first electrode facing to the second electrode;

starting material gas supply means that supplies starting material gas containing metal particles or metal compound gas to be a photocatalyst element in oxygen gas to the discharge gap part in the photocatalyst material producing unit; and

an AC power source that applies an AC voltage between the first electrode and the second electrode to introduce AC power of a predetermined power density into the discharge zone and causes dielectric barrier discharge (silent discharge or creeping discharge) via the dielectric material;

wherein a state where oxygen gas and ozone gas exist in the discharge gap part is created by the dielectric barrier discharge (silent discharge or creeping discharge), and

the metal particles or the metal compound gas contained

in the oxygen gas is modified to photocatalyst particles by a mutual chemical reaction of high-field intermittent discharge plasma due to the dielectric barrier discharge (silent discharge or creeping discharge) and oxygen gas and ozone gas.